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NEW REPORTS OF RUST FUNGI (*UREDINALES*) FROM NIGERIA

Nuevos registros de royas (*Uredinales*) de Nigeria

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ABSTRACT
Five species of rust fungi from Nigeria are treated. *Coleosporium plumeriae* and *Puccinia mogiphanis* (originally from tropical America) are reported for the first time from África. *Hemileia chlorocodonis* is reported for the first time in Nigeria and on a new host, *Tacazzea apiculata* (*Apocynaceae*). Descriptions and comments are provided for the relatively rare species *Dietelia codiaei* and *Endophyllum cassiae*.

Key words. Africa, *Coleosporium plumeriae*, *Dietelia codiaei*, *Endophyllum cassiae*, *Hemileia chlorocodonis*, *Puccinia mogiphanis.*

RESUMEN
En este trabajo se tratan cinco especies de royas de Nigeria. *Coleosporium plumeriae* y *Puccinia mogiphanis* (originalmente de América Tropical) son reportadas por primera vez en Africa. Se reporta por primera vez *Hemileia chlorocodonis* en Nigeria, sobre un nuevo hospedante (*Tacazzea apiculata* - *Apocynaceae*). Se proveen también descripción y comentarios sobre las especies exóticas *Dietelia codiaei* y *Endophyllum cassiae*.

Palabras clave. África, *Coleosporium plumeriae*, *Dietelia codiaei*, *Endophyllum cassiae*, *Hemileia chlorocodonis*, *Puccinia mogiphanis.*

INTRODUCTION

Rust fungi (*Uredinales*) are a relatively well-known group of fungi in most parts of the world. However, on the African continent, these studies have been limited primarily to South Africa (Doidge 1927-1948, summarized in Crous *et al.* 2000) and Nigeria where the rust fungi have been studied extensively by Dan O. Eboh (Eboh 1978, 1981, 1983 a-c, 1984, 1985a-b, 1986 a-b, 1989, Eboh & Cummins 1980, Eboh & Hennen 1987). In the continued exploration of rust fungi in Nigeria, two species are reported here for the first time from Africa, one species is reported for the first time from Nigeria and on a new host, and two additional rare rust species are described. Additional images of the species treated in this paper and descriptions and images of other rust fungi can be found on the web site of USDA-ARS Systematic Botany and Mycology Laboratory, under

Fungi Online - Images (http://nt.ars-grin.gov/taxadescriptions/imageview/imageviewflash/imagaViewerFinal.cfm?whichdataset=Rusts).

1. ***Coleosporium plumeriae*** **Pat., Bull. Soc. Mycol. France 18:178 (1902).** Fig. 1, a-c
= *Coleosporium domingensis* Arthur, Amer. J. Bot. 5:329 (1918).
= *Uredo domingensis* Berk., Ann. Mag. Nat. Hist. 9:9 (1852).
= *Uredo plumeriicola* Henn., Hedwigia 43:161 (1904).

Spermogonia and aecia unknown. Uredinia hypophyllous, scattered between veins, 0.3-0.8 mm wide, erumpent, powdery, without peridium, orange-yellowish fading to pale yellow; urediniospores 25-32 × 16-24 µm, broadly ellipsoid to subglobose or angular, catenulate, coarsely verrucose, wall 1.5-2 µm, with abundant capitate, annulated tubercles 1.5-3 µm long and 1-2.5 µm wide, germ pores 2 to 4, scattered, obscure. Telia hypophyllous, scattered between veins, 0.1-0.3 mm wide, erumpent, smooth, of numerous teliospores in compact layer, gelatinous when moist, orange-yellow to reddish orange; teliospores 64-85 × 23-32 µm, oblong to clavate, rounded at apex and narrowing at base, contents oily and refractive, orange-yellow, walls smooth, hyaline, thicker at apex than at sides.

Specimen examined: Nigeria, Nsukka, on *Plumeria rubra* L. (*Apocynaceae*), leg. Dan O. Eboh, 10.12.2003 (BPI 843715) II.

Coleosporium plumeriae is reported here for the first time from Africa. This rust is relatively common in tropical and semi-tropical regions in the western hemisphere and is known from the Caribbean Islands, Central America, Mexico, northern South America, and the United States (Florida, Hawaii) (Farr *et al.* n.d.). It also has been reported from Micronesia (Gonzalez-Ball and Ono 1998) and a greenhouse in Canada (Traquair and Kokko 1980). This rust may have been introduced into Nigeria on its ornamental host plant *Plumeria rubra* ('frangipani' or 'plumeria').

Arthur (1918) transferred *Uredo domingensis* to *Coleosporium*, however, he only observed uredinia on the type specimen. For this reason his publication of this name should be considered a new species rather than a new combination. Arthur (1918) considered *Uredo plumeriicola* to be a synonym of *C. domingensis*.

Coleosporium plumeriae has priority over *C. domingensis* because it was the first valid description of the telial stage. This species was originally spelled *Coleosporium "plumierae"*. However, because the specific epithet was based on the host and the accepted spelling of the host genus is *Plumeria,* the correct specific epithet is *"plumeriae"* (Art. 60.12, the International Code of Botanical Nomenclature (ICBN), Greuter *et al.* 2000). Traquair and Kokko (1980) studied this species using light and scanning electron microscopy and provided a detailed description.

2. ***Dietelia codiaei*** **Boerema, Versl. Meded. Plziektenk. Dienst Wageningen 153 (Jaarb. 1978):16 (1979).**
≡ *Aecidium codiaei* Syd., Ann. Mycol. 37:198 (1939).

Spermogonia, aecia and uredinia unknown. Telia hypophyllous, in groups on orange pustules 3-8 mm diameter, sometimes following veins, infection sometimes causing distortion of apical leaves, erumpent, hemispheric, yellow-brown, 200-300 µm diameter, surrounded by host tissue. Peridium erect often shrinking away from the host, dehiscing irregularly at top and becoming revolute; peridial cells hyaline, rhomboid to rectangular, 18-28 × 12-18 µm, inner walls 2-3 µm thick with coarsely verrucose surfaces, tubercles forming humps or short ridges occasionally giving a striate appearance, especially on outer walls which are 4-6 µm thick. Teliospores globoid-polygonal to oblong, (14.5) 17-22 (26) × 10-14.5 (20.5) µm, wall 1-1.5 µm thick, hyaline to golden, smooth to minutely verrucose. Intercalary cells not observed.

Specimen examined: Nigeria, Anambra State, Ire Village, Obosi, on *Codiaeum variegatum* (L.) A. Juss. (*Euphorbiaceae*), leg. Dan O. Eboh, 15. 12. 2003 (BPI 843629).

This rust was originally described from Ghana (Mangoasi) as *Aecidium codiaei* (Sydow 1939). Eboh (1981) reported it under that name from Nigeria. This species is known from several countries in Africa (Ghana, Ivory Coast, Nigeria, and Togo) and has been introduced into the Netherlands and United Kingdom (Boerema *et al.* 1994).

Based on material on *Codiaeum* imported from Ghana into the Netherlands, Boerema and Link (1979) determined that the aecioid sori and spores were actually telia and teliospores, thus they described this species in the teleomorph genus *Dietelia*.

A detailed study of the biology and morphology of *D. codiaei* was undertaken in the United Kingdom after the rust was introduced into that area (Boerema *et al.* 1994). The teliospores appear nearly smooth under the light microscope, but finely verrucose under the scanning electron microscope with refractive granules over the inconspicuous pores (Boerema *et al.* 1994).

3. ***Endophyllum cassiae*** **F. Stevens & Mendiola, Philipp. Agric. 20: 16 (1931).**

= *Aecidium cassiae* Bres., Rev. Mycol. 13: 66 (1891).
= *Aecidium torae* Henn., Bot. Jahrb. Syst. 34: 42 (1904).
= *Endophyllum cassiae* Nagaraj, Govindu & Thirum., Sydowia 25: 158 (1971).

Spermogonia, aecia and uredinia not observed. Leaf spots chlorotic when young, becoming brown when older. Telia amphigenous, mainly hypophyllous, subepidermal becoming erumpent, arranged in circles and associated with leaf spots up to 8 mm diameter, 150-300 µm diameter, cupulate, peridium 75-150 µm above leaf surface. Peridial cells hyaline, irregularly arranged, 11-28 × 10-21 µm, thick walled, outside wall strongly verrucose, inside wall minutely verrucose. Teliospores catenulate, globose to oblong, 18 × 18-21 µm, orange yellowish, minutely verrucose, wall 1-1.5 µm thick, germ pores obscure.

Specimens examined: Nigeria, Anambra State, Ire Village, Obosi, on *Senna obtusifolia* (L.) H.S. Irwin and Barneby (*Fabaceae*), 29.9.2004, leg. Dan O. Eboh (BPI 871369) III.

Endophyllum cassiae was reported from India, the Philippines, and tropical Africa (Buriticá 1991) and also Brunei and Malaysia (Farr *et al.* n.d.). Lenné (1990) reported this species as *Aecidium cassiae* from Nigeria based on herbarium records from IMI.

4. ***Hemileia chlorocodonis*** **Syd. & P. Syd. , Ann. Mycol. 11:55. 1913.** Fig. 1, d-f

Spermogonia and aecia unknown. Uredinia composed of fascicles of sporogenous cells that emerge through stomata becoming suprastomatal, mainly hypophyllous, numerous, often aggregated in angular spots surrounded by veins corresponding to pale, angular leaf spots on the upper leaf surface, 0.5-2.5 mm diameter, pale yellow; urediniospores produced on short pedicels, 20-28 × 19-25 µm, ovate to obovate, asymmetric, strongly echinulate, sometimes less echinulate toward ventral side, wall 1.5-2 µm thick, hyaline to sub-hyaline. Telia similar to and intermingled with uredinia, hypophyllous, suprastomatal, pale yellow; teliospores one-celled, produced on short pedicels, 16.5-21.5 µm long × 16.5-24 µm wide, smooth, globose, subglobose, clavate or triangular, sometimes wider than tall, sometimes with an umbo, wall 1 µm thick, 2 µm thick at the base, no germ pore observed, apparently obscure.

Specimens examined: Tanzania ("German East Africa"), Usambara, Amani, on *Mondia whitei* (Hook. f.) Skeels (as *Chlorocodon whitei* Hook. f.), Oct. 1912, *A. Zimmerman 3829*, Fungi Exotici Exsiccati 221 (BPI) II, (NY 00053759) II-III Isotypes; Nigeria, Nsukka, University of Nigeria, Botanical Garden, on *Tacazzea apiculata* Oliv. (*Apocynaceae*, *Periplocoideae*), leg. Dan O. Eboh, 9. 1. 2001 (BPI 843634) (II-III); Sudan, Katire, on *Tacazzea apiculata* Oliv., leg. S.A.J. Tarr (JT 2565), 22. 11. 1954 (IMI 59108) II-III.

Hemileia chlorocodonis Syd. & P. Syd. has been reported on *Mondia whitei* (Hook. f.) Skeels (as *Chlorocodon whitei* Hook. f.) from Malawi, Tanzania and Uganda (Peregrine and Siddiqi 1972, Wakefield and Hansford 1949). Tarr (1963) reported *Hemileia* sp. on *Tacazzea apiculata* from southern Sudan (Katire) that is herein identified as *H. chlorodonis* (IMI 59108). *Tacazzea apiculata* is a weedy plant known in Africa as "lufute katika monga," in the *Apocynaceae* including the *Asclepiadaceae* (Endress and Bruyns 2000).

A rust similar to *Hemileia chlorocodonis* is *H. scitula* Syd. (Sydow 1937) on *Periploca nigrescens* Afzel. [≡ *Parquetina nigrescens* (Afzel.) Bullock, *Apocynaceae*, *Periplocoideae*] described from Sierra Leone. Although *H. scitula* is a teleomorph name, only uredinia were described; no telia were found on the type or other specimens examined of *H. scitula.* Uredinia of *Hemileia scitula* are hypophyllous, irregularly distributed, and not associated with leaf spots while those of *H. chlorocodonis* also are mainly hypophyllous but are arranged in angular spots surrounded by veins and associated with leaf spots on the upper leaf surface. The urediniospores of *H. scitula* are strongly and evenly echinulate while those of *H. chlorocodonis* are strongly echinulate, sometimes less echinulate toward the ventral side. No telia are known for *H. scitula* while *H. chlorocodonis* produces telia that are intermingled with uredinia.

Specimens examined of *Hemileia scitula* on *Periploca nigrescens* Afzel., Ghana, (Gold Coast Colony), Bunsu, leg. S.J. Hughes, 7. 6. 1949 (IMI 42173) II; Sierra Leone, Njala, leg. F.C. Deighton M1053, 5. 11. 1936 (IMI 43274) II, Type; Songo, leg. F.C. Deighton M1136, 28. 11. 1936 (IMI 43275) II; Tawia (Bake Loko), leg. F.C. Deighton M1602, 17. 2. 1938 (IMI 43276) II; Kangakua?, leg. F.C. Deighton M5813, 8. 2. 1954, (IMI 56542) II.

In addition to those mentioned above, two other species of *Hemileia* have been described on members of the subfamily *Periplocoideae*.

Hemileia cryptostegiae Vienn.-Bourg. (Viennot- Bourgin 1963), a synonym of *Scopella cryptostegiae* Cummins (Cummins 1940), was described on *Cryptostegia madagascarensis.* This species is now regarded as *Maravalia cryptostegiae* (Cummins) Y. Ono (Ono 1984) and has been reported on a number of species in the *Apocynaceae* (Evans 1993, Evans and Tomley 1994). Teliospores of *M. cryptostegiae* are 23-33(42) × (12)14-18 µm while teliospores of *H. chlorocodonis* are 16.5-21.5 × 16.5-24 µm.

Specimen examined: *Uredo cryptostegiae* on *Cryptostegia madagascariensis* Bojer ex Decne.: Madagascar, Majunga, leg. B. Palm, 4. 1912, Type. (Microm. Rar. Sel. 1660, BPI 154572) II-III.

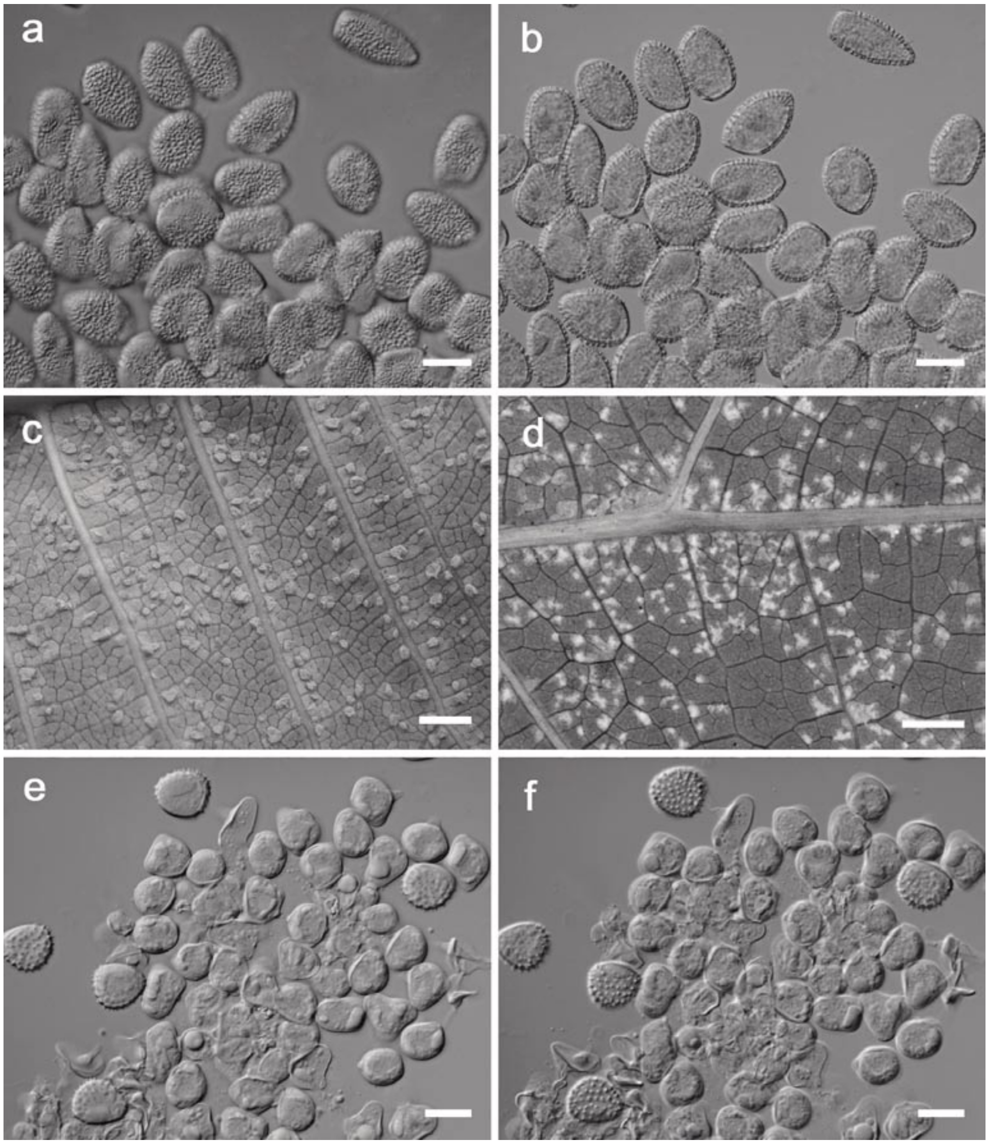

Fig 1. a. b. c. *Coleosporium plumeriae* on *Plumeria* sp. **a.** Urediniospores, surface view. Bar = 20 µm. **b.** Urediniospores, median view. Bar = 20 µm. **c.** Uredinial sori on lower leaf surface. Bar = 0.5 cm. **d. e. f.** *Hemileia chlorocodonis* on *Tacazzea apiculata*. **d.** Sori on lower leaf surface corresponding to chlorotic spots on upper surface. Bar = 0.5 cm. **e.** Telia composed of fascicles of sporogenous cells, teliospores (smooth) mostly attached sporogenous cells, and loose urediniospores (strongly echinulate), median view. Bar = 25 µm. **f.** Surface view of "e." Bar = 25 µm.

Three other species of *Hemileia* for which only uredinia are known were described on *Apocynaceae,* subfamilies *Asclepiadoideae* and *Secamonoideae*. *Hemileia mysorensis* Thirum. & Goplkr. was reported from India (Thirumalachar 1947) on *Gymnema* sp. and *Gymnema sylvestre* (Retz.) R. Br. ex Schult. (≡ *Periploca sylvestris* Retz.,). Only uredinia were described and urediniospores measured 30-45 × 19-25 µm, longer than those of *Hemileia chlorocodonis* (20-28 × 19-25 µm). *Hemileia secamones* Wakef. & Hansf. (Wakefield and Hansford 1949) was reported on *Secamones* sp. from Uganda. Only uredinia were described with urediniospores 18-23 × 15-22 µm, smaller than the ones of *Hemileia chlorocodonis* (20-28 × 19-25 µm). *Hemileia sonsensis* (Henn.) P. Syd. & Syd. (Sydow and Sydow 1915) (anam. *Uredo sonsensis* Henn. 1907), produces urediniospores that are 22-32 × 18-25 µm, somewhat longer than *H. chlorocodonis*, and with an aculeate convex surface and smooth near the base. Because no teleomorph was described, these cannot be named in the teleomorph genus *Hemileia* based on the current ICBN (Greuter *et al.* 2000).

5. *Puccinia mogiphanis* Arthur, Bot. Gaz. 65:469 (1918). Fig. 2, a-d

= *Uredo maculans* Pat. & Gaillard, Bull. Soc. Mycol. France 4:98 (1888).
= *Uredo mogiphanis* Juel, Bih. Kogl. Svensk. Vetensk.-Akad. Handl. 23:24 (1897).
= *Uredo telantherae* Viégas, Bragantia 5:90 (1945).
= *Uredo panamensis* Arthur, Bull. Torrey Bot. Club 45: 155 (1918).

Spermogonia amphigenous, when hypophyllous irregularly scattered among aecia. Aecia hypophyllous, in circular groups less than 5 mm diameter, cupulate, 0.25-0.3 mm diameter; aeciospores sphaeroid to ellipsoidal, 23-42 µm, wall hyaline, minutely verrucose, 1-1.5 µm thick. Uredinia amphigenous but mostly hypophyllous, sometimes caulicolous, irregularly scattered or in groups less than 7 mm diam, circular, cinnamon, about 1 mm diameter; urediniospores sphaeroid to broadly ellipsoidal, 28-43 × 24-40 µm, cell wall sienna, 1.5-4 µm thick, densely verrucose-echinulate, pores 3-4(6), equatorial or scattered. Telia amphigenous or caulicolous, irregularly scattered, black, less than 1.5 mm diameter; teliospores ellipsoidal, obtuse above, usually slightly constricted at septum, round or attenuated below, 48-60 × 30-37 µm, wall 3-6 µm thick at sides, up to 6-12 µm thick above, smooth, sienna to umber, germ pores apical; pedicels hyaline, basal, up to 300 µm long.

Specimens examined:
As *Puccinia mogiphanis:* on *Achyranthes* sp. (*Amaranthaceae*), Ecuador, Quito, leg. E.W.D. Holway & M.M. Holway 913, 18. 8. 1920 (BPI 86503) I-II; Peru, Pasco, leg. J.N. Rose & J.N. Rose 18804, 6.8.1914 (BPI 848454) II-III; (BPI 81799) II; on *Alternanthera brasiliana* (L.) Kuntze (*Amaranthaceae*); Nigeria, Nsukka, leg. Dan O. Eboh, 12. 6. 2001 (BPI 843714) II; Obosi, St. John's Catholic Church, leg. Dan O. Eboh, 8. 12. 2003 (BPI 843713) II; on *Alternanthera puberula* (Mart.) D. Dietr. (*Amaranthaceae*); Brazil, Rio de Janeiro, Nictheory, leg. E.W.D. Holway & M.M. Holway, 22. 8. 1921 (BPI 86505) II; (BPI 86504) II; on *Alternanthera ramosissima* (Mart.) Chodat (*Amaranthaceae*); São Paulo, leg. E.W.D. Holway & M.M. Holway, 22. 1.1922 (BPI 86506) II; on *Mogiphanes* sp. (*Amaranthaceae*); Mato Grosso, leg. C.A.M. Linder, 17. 6. 1904 (BPI 848453) II.
As *Uredo maculans*: on *Achyranthes* sp., Costa Rica, Alajuela, leg. E.W.D. Holway, 7. 1. 1916 (BPI 155253) II; on *Alternanthera flavescens* Kunth, United States, Florida, leg. H.L. Rubin, 24. 1. 1968 (BPI 155256) II; Venezuela, Caracas, El Valle, leg. A.S. Müller, 27. 9. 1939, (BPI 847371) II; on *Alternanthera williamsii* (Standl.) Standl., Panama, Ancon, leg. F.L. Stevens 839, 26. 9. 1924 (BPI 155259) II; on *Pfaffia iresinoides* (Kunth) Spreng. (*Amaranthaceae*), Trinidad and Tobago, Trinidad, Lady Chancellor Road, leg. F.J. Seaver, 8. 3. 1921 (BPI 155261) II.

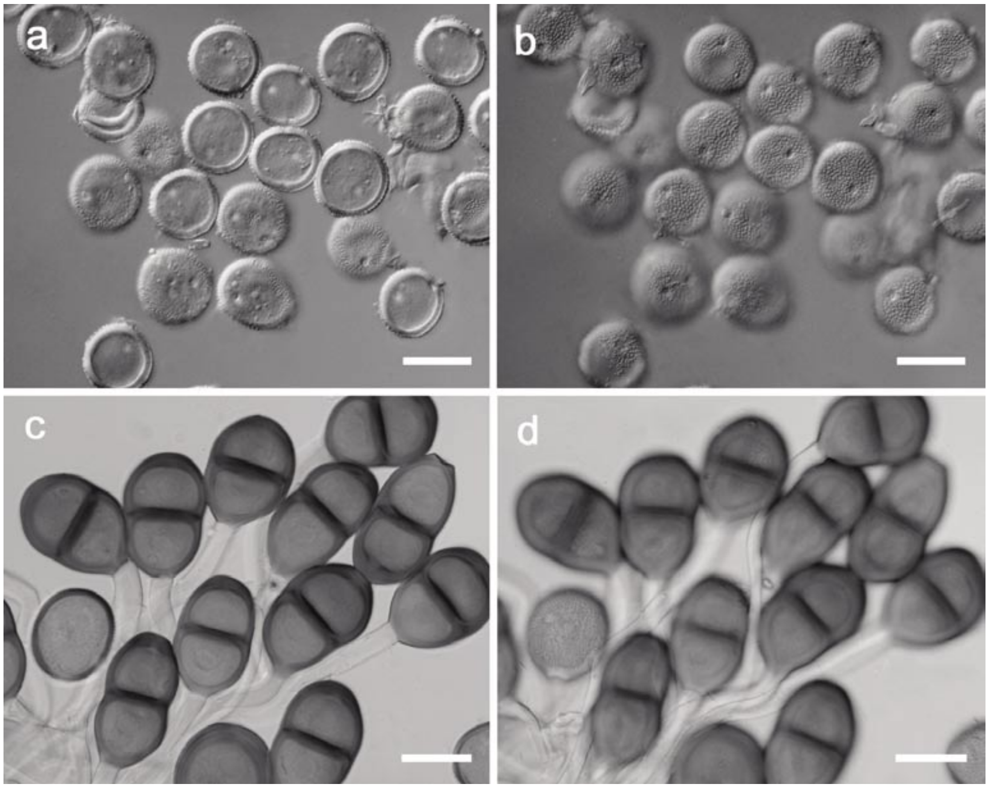

Fig 2. *Puccinia mogiphanis*. **a.** Urediniospores, median view. **b.** Urediniospores, surface view. **c.** Teliospores, median view. **d.** Teliospores, surface view. Bars = 20 µm.

As *Uredo mogiphanis*, on *Mogiphanes* sp., Brazil, Matto Grosso, Cuyaba, leg. C.M.A. Lindman, 17. 6. 1894. Type (BPI 155309) II.

This is the first report of *Puccinia mogiphanis* from Africa. The fungus previously has been reported from the Caribbean and Central and South America (Farr *et al.* n.d.). Only the uredinial stage was found in Nigeria where the rust is abundant from March to September. Telia appear to be rare and were found only in one of the collections examined (BPI 848454, from Peru). This description of the telia is based on that Peruvian specimen and Laundon (1965).

The host *Alternanthera brasiliana* (Brazilian joyweed) is known primarily from the Americas extending from Mexico south to Argentina. This ornamental plant was introduced into Nigeria approximately 15 years ago and is now widely distributed. It seems likely that the rust was introduced with the host.

Hennen and McCain (1993) considered *Uredo paraensis* Arthur a synonym of *Uredo maculans* Pat. & Gaillard and thus of *Puccinia mogiphanis*.

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